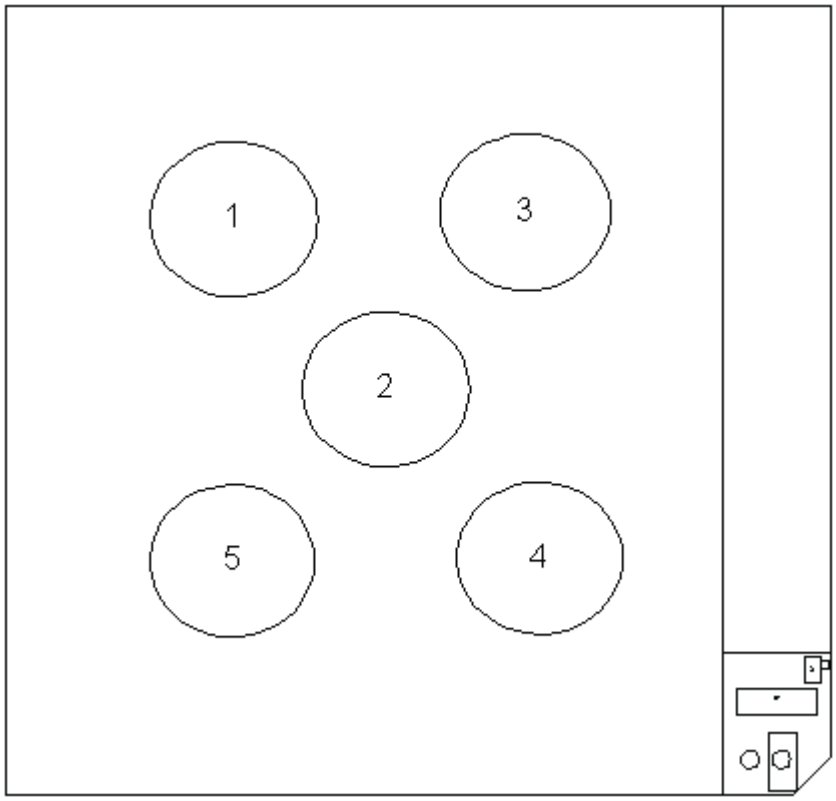
PHILIPS

Philips Medical Systems

5-field measuring chamber

9890 000 7000x

Level 0 Documentation



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SERVICE MANUAL – UNIT

742

5 – field measuring chamber

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List of pages and drawings (LOPAD)

Manual Order No: 4512 988 00442
released: 08/2007

1 ... 32 (07.0)

Contents

1. INTRODUCTION AND TECHNICAL DATA

1.1. PURPOSE OF MANUAL

This manual describes the function and service-relevant activities for the 5-field bucky chamber.

1.2. ITEMS SUPPLIED

9890 000 7000x 5-field bucky chamber
Projection plates SID 110 cm and 180 cm

1.3. COMPATIBILITY

9890 000 02001 Optimus RAD / RF
Bucky 5-field chamber possible in all releases but 5 fields accessible only for rel. ≥ 3.6
9890 000 70151 Velara RF rel. ≥ 2.7.
9890 000 70161 Velara GCF rel. ≥ 2.7.

1.4. TECHNICAL DATA

1.4.1. Mechanical data

Crate / Box	**Dimension (mm)**			**Weight (Newton)** (10 N = 1 Kg)
	Length	Width	Height	
Packed	590	530	70	30
Transport	590	530	70	30
Installed	505	458	11	18

1.4.2. Environmental data

	Operation	**Stock / Transport**
Temperature in °**Celsius**	0 / + 40	- 40 / + 75
Temperature in °**Celsius / Hour**	N/A	N/A
Humidity in % (non-condensing)	5 / 95	5 / 95
Gradient in % **/ hour**	N/A	N/A
Vibrations / Shock range in **Hz**	5 - 500	5 - 500
Vibrations / Shock amplitude in **mm**		
Vibrations / Shock acceleration in **g**	0.25 peak	1.0 peak
Shock acceleration in **g**	5 peak	30 peak
Shock pulse duration in **msec**	11	11
Air pressure in **Hecto-pascal**	700 / 1100	700 / 1100

Acoustic noise level : N/A
Air cooling : N/A
EMC : IEC 950

1.4.3. Electrical data

Equipment related:

Power required	:	0.375 VA
Nominal voltages	:	15 VDC
Nominal current	:	0.025 A
Nominal frequency	:	N/A
Heat emission		
standby	:	N/A W (1 Joule/sec = 1 Watt)
in operation	:	N/A W (1 Joule/sec = 1 Watt)

1.4.4. Tools/material required

Pre-installation

Delivered	:	N/A
To be ordered	:	N/A
To be arranged locally	:	TC129 Tool kit, standard

Installation

Delivered	:	N/A
To be ordered	:	N/A
To be arranged locally	:	TC129 Tool kit, standard TC017 Densitometer, X-Rite 331X TC185 Dosemeter, Unfors 578-PMS

1.5. SAFETY INFORMATION

The general legal and factory safety recommendations for this X-ray equipment and the following recommendations must be strictly observed!
Start of installation, operation and maintenance work and especially electrical work must only be executed by trained and authorized persons. This equipment must only be serviced by properly educated service specialists who have received general and system-specific training as performed by Philips Medical Systems.

Warning

The system/component must be switched OFF during replacement work.
Any X-ray unit produces ionizing radiation which may be harmful if not properly controlled. Therefore, it is recommended that this equipment be operated in accordance with the guidelines set down by the national council on radiation protection.

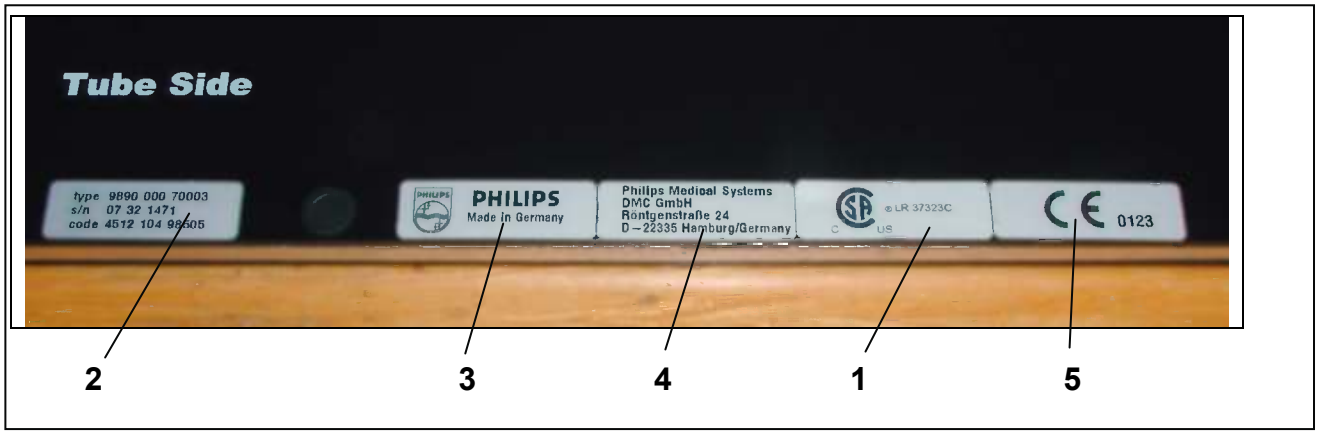
1.6. COMPLIANCE INFORMATION

N/A

1.7. EQUIPMENT IDENTIFICATION AND LABELING

The approval label is located on the measuring chamber.

1	CSA recognition
2	PEI and serial number
3	Brand label
4	PMS address label
5	CE recognition



1.8. ABBREVIATIONS AND DEFINITIONS

Abbreviation	Explanation
PMS	Philips Medical Systems
POST	Power-On Self Test
BIST	Built-In Self Test

1.9. MANUAL HISTORY

Date	Version	Name	Reason of changes
09.02.2004	0.1	G. Kramm	First initial draft
21.04.2004	0.2	G. Kramm	Update and changes implemented
19.04.2004	1.0	G. Kramm	Acceptance info from Mr. A. Duve inserted
10.06.2004	1.0	G. Kramm	Cable installation part finalized.
25.10.2004	1.1	G. Kramm	Contents and test procedure 7.1.4 as well as 7.4 finalized.
04.04.2005	1.2	A. Duve	Added info 7.21 Field sensitivity and Acceptance Note page 28
31.08.2007	AB	Th. Frenschek	UL to CSA

2. INSTALLATION

Install the measuring chamber according to the system manual installation.

2.1. INTRODUCTION, TOOLS ROOM CHECK

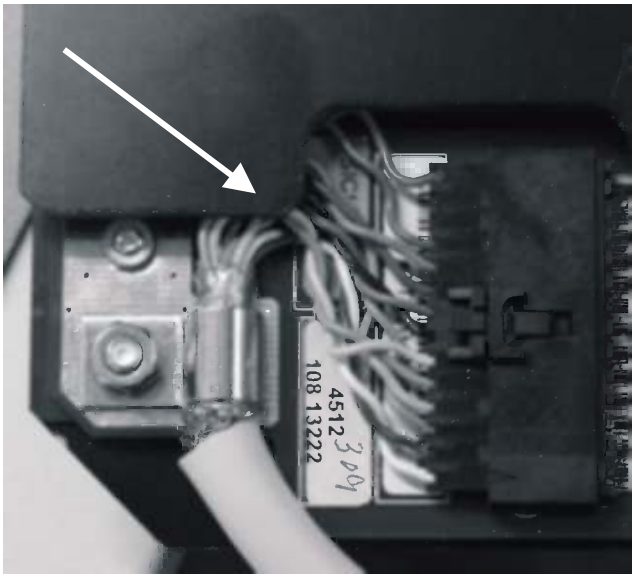
N/A

2.2. UNPACK, TRANSPORT, MOUNT

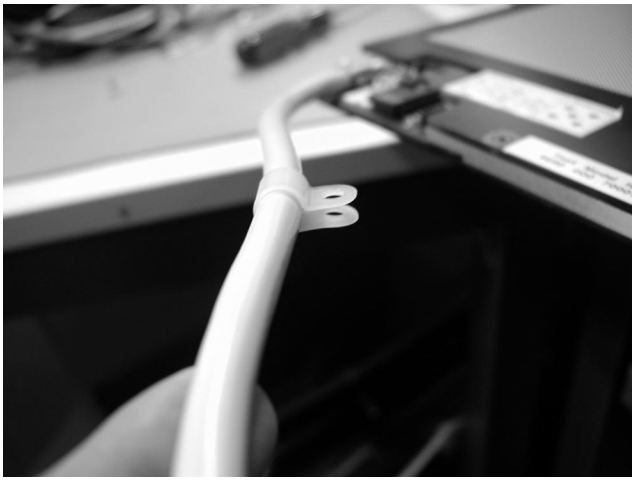
N/A

2.3. INSTALLATION

- Connect the plug.
- Push all wires under the metal cover plate, the wires should be covered completely by the metal plate.
- Fix the cable with the metal clamp to establish proper cable screen connection to ground. Use a washer and nut to fix the cable.



- Fit the plastic clamp to the cable as shown.



- Fix the plastic clamp to the chamber bottom side with the delivered screw.

- Route the cables.

2.4. SETTING-TO-WORK

N/A

2.5. PERFORMANCE CHECK

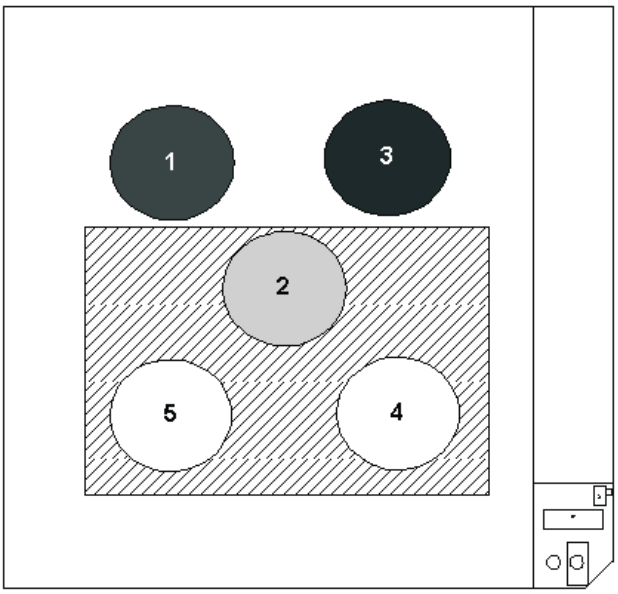
2.5.1. Check of the order of the measuring fields and check for proper operation

1…2 mm thick lead cover strip of 180 x 250 mm size required.

- Select exposure voltage 40kV … 60kV.

2.5.2. 3-field measuring chambers

- Insert a large cassette.
- Select the measuring fields 1 + 3.
- Cover the measuring fields 2 + 4 + 5.
- Switch an exposure.
  The Amplimat terminates the exposure.
- Switch off measuring fields 1 + 3.
- Select the field 2.
- Switch an exposure.
- The exposure must show a noticeably longer switching time.
- If not, check the switch S1 position.



2.6. HANDOVER PREPARATION

N/A

2.7. OPTIONS

N/A

3. FAULT FINDING

N/A

4. REPLACEMENTS

4.1. REPLACEMENT PROCEDURE OF 5-FIELD BUCKY CHAMBER

4.1.1. 5-field bucky chamber

Tools required	TC129 Tool kit, standard TC017 Densitometer, X-Rite 331X TC185 Dosemeter, Unfors 578-PMS
Time/manpower	0.5 h / 1 service engineer
Preconditions	N/A

Replacement procedure

- Replace the measuring chamber according to the SMI.

5. ADJUSTMENTS

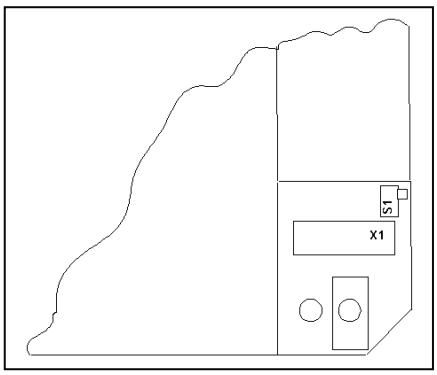
N/A

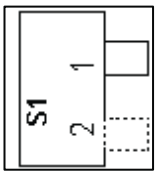
6. PROGRAMMING

6.1. HARDWARE

The configuration (two groups of 3 fields or all 5 fields) is selectable with switch S1.

	S1	
Selectable fields	**1**	**2**
All 5 fields	**X**	
Fields, 1 + 2 + 3	**X**	
Fields, 4 + 2 + 5		**X**





Selectable field groups	Connector pins *				
	Pin 7	**Pin 6**	**Pin 8**	**Pin 9**	**Pin 10**
5 fields	Field 1	Field 2	Field 3	Field 4	Field 5
3 fields	Field 1	Field 2	Field 3	-	-
3 fields	Field 4	Field 2	Field 5		

*different cable types for 5-field- and 3-field measuring chamber

6.2. SOFTWARE

OPTIMUS RAD / RF / C

Programming of the chamber

Files are available on the CS CD-ROM and the service PC installation of AGenT vers. 2.x.x or higher.

Menu
Program → Dose Rate Control → Amplimat → Chamber 1 → Data set 1...5 → Start automatic DRC processing “Yes”

film	FILM.TDL	→
screen	SCREEN.TDL	→
chamber	CHAMBER.TDL	→ **9890 000 7000x Bucky 5 Field**
cassette	CASSETTE.TDL	→
correction factor	SYSCOR.TDL	→

Velara RF / GCF

Subsystem Manual Installation

7. ACCEPTANCE

Tools required	TC129 Tool kit, standard TC095 Oscilloscope TC091 Multimeter TC014 D-connector measuring board
Time/manpower	0.5 h / 1 service engineer
Preconditions	N/A

7.1. INTRODUCTION

7.1.1. Sensitivity of Amplimat chamber fields

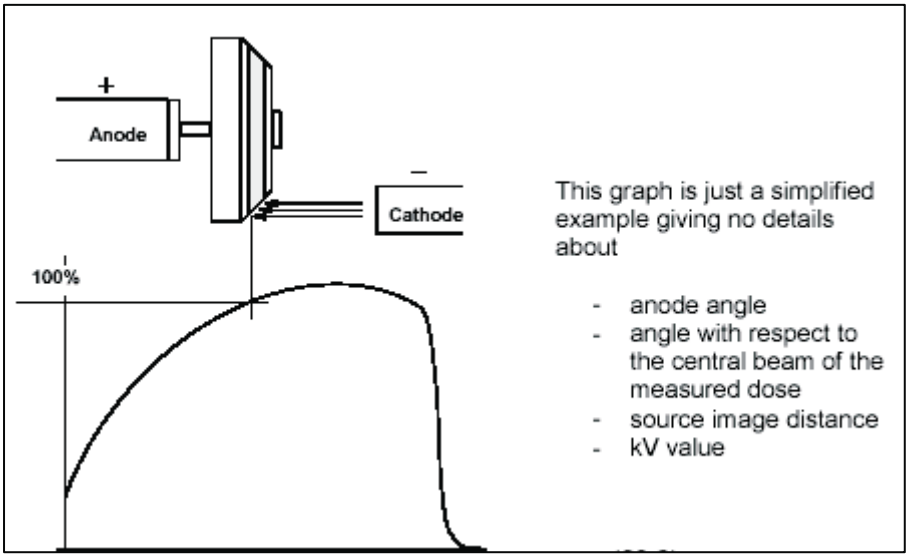
All five fields have the same sensitivity (dose [µGy] / density voltage [V]).

7.1.2. Physical side effects

The heel effect results in an inhomogeneous dose across the image area parallel to the rotation axis of the anode.

Simplified one can say that the dose decreases from the center radiation beam axis (90° with respect to the rotation axis) heading for the anode, it slightly increases from the center beam point in the direction of the cathode.
The values given in the "anode position factor" tables are the reciprocal multipliers of the typical dose values compared to the basic dose value of **1** measured at the center field.
The dose differences caused by the heel effect are also anode angle dependent.
The dose values to the sides of the central axis (left and right) are just focus distance dependent and are symmetrical.
With a 25mm aluminum filter (chapter 2.4 for the field sensitivity measurements), one does not get a value > 1, which is the base value of the central beam at the center field. The values shown in the graph are without filter.

Depending on the chamber position (field selection) and tube rotating axis there might be symmetrical as well as asymmetrical side field sensitivities due to the heel effect.



7.1.3. Functional tests of Amplimat chambers and generator AEC functions

Terms:
detector = measuring field
receptor = cassette / film / image intensifier
absorber = phantom, patient equivalent

- The given tolerances in this manual **exclude the deviation** of the test equipment on site.
- The nominal density D_N of a film-screen combination used for the test has been adjusted to any O.D. (optical density) factor according to the customers taste.
- Use water as phantom (phantom thickness = water height = kV dependent).
- The film processing is considered to be ok.
- The generator 'built-in mAs read-back circuit' can be used instead of or additionally to an external, non-invasive mAs measurement.

7.1.4. Dark current check of ionization chamber

Purpose
There should be no drift of the chamber signal once it is in a state ready to receive dose.
Additionally one also checks the proper insulation of the chamber (path of the ground connection) and the insulation of the sensor signal against electrical ground.
The drift of the detector/chamber signal (dark current) can be checked with a DVM, but insulation problems (ground connections to the chamber body) can only be detected with an oscilloscope. The measuring points are the same as for the DVM.

Procedure Optimus RAD + R/F + C

15-pin Sub-D measuring chamber connection

1	PO_400V	9	
2		10	
3	field 3 right	11	field 1 left
4	REL	12	field 2 center
5	**PO_15**	13	GND
6	NG_15V	14	field 4 right
7	**signal**	15	field 5 left
8	RF_0V		

REL connections for fields
1st group
field 1 pins 11 – 4
field 3 pins 3 – 4
field 2 pins 12 – 4

2nd group
field 5 pins 3 – 4
field 4 pins 11 – 4

- Select auxiliaries with an ionization chamber.
- Connect a DVM or oscilloscope at **X4 DS_MC_SG** of PCB basic interface **EZ150** and **X3 DS_MC_0V** or at the Sub-D connector input with an adapter at **pin 7 = signal** and **pin 13 = GND**.
- Since the Optimus does not provide a test switch, the REL signal of the selected chamber has manually to be activated:
  Place a link between **pin 4** (+15V supply) and **pin 5** (REL signal) of the selected chamber.
  Activating the REL signal opens the short link of the integration capacitor of the chamber amplifier.

  The link can also be established when PCB EZ150 is on extender boards or directly at the back panel, signals see drawing Basic interface Z1-6 of the generator manual.

Procedure Velara RF / GCF:

- Select auxiliaries with an ionization chamber.
- Connect a DVM or oscilloscope at the Sub-D connector input with an adapter at **pin 7 = signal** and **pin 13 = GND**.

Since the Velara does not provide a test switch, the REL signal of the selected chamber has to be activated manually:
Make a link between **pin 4** (+15V supply) and **pin 5** (REL signal) of the selected chamber.
Activating the REL signal opens the short link of the integration capacitor of the chamber amplifier.
[**Attention!** In case the chamber is of an old type with a +40V chamber amplifier supply,]
[the test **cannot** be carried out, there is no access to a +15V supply voltage.

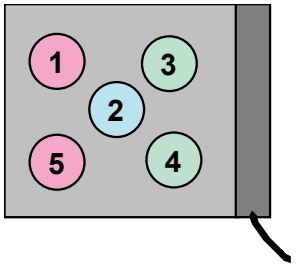
Result

The chamber offset < 10mV in the beginning of the test can rise by max +4mV/sec or –8mV/sec depending on the temperature and the climatic conditions (20-25°C, 45-75% relative humidity).
At 40°C and 85% relative humidity it might rise up to ±40mV/sec.

nominal offset				drift in 30 seconds	
chamber 1	field 1		mV		mV
	field 2		mV		mV
	field 3		mV		mV
	field 4		mV		mV
	field 5		mV		mV
chamber 2	field 1		mV		mV
	field 2		mV		mV
	field 3		mV		mV
	field 4		mV		mV
	field 5		mV		mV
chamber 3	field 1		mV		mV
	field 2		mV		mV
	field 3		mV		mV
	field 4		mV		mV
	field 5		mV		mV

Any kind of modulation on the chamber signal can indicate a ground connection to the chamber body, look for insulation problems.
The ground line coming from the generator (Optimus / Velara pin 13 to chamber PHX109) is connected to PHX110 and then to the chamber cable screen, the cable screen must not have a ground connection at the generator side.

7.2. CHAMBER FIELD SENSITIVITY TEST



7.2.1. Prerequisites / Field sensitivity measurement

The collimator shutters must be opened to a size that all fields are fully covered by light and X-ray.
Insert a 21 / 25mm Al filter at the collimator.

The selection of the chamber fields takes place via the 5-field module and the generator desk control keys.
Bucky: Insert the biggest cassette.

To avoid acceptance problems due to average default tube data (angle / yield / SID-dependent heel factors) measure the dose at each chamber field (table and wallstand) for each individual tube first.
Set 70kV – 200mA – 50ms or a similar kV-mAs value, use the same parameters for all fields.
Do not use a filter.
Measure the dose **at the center of each field** on the tabletop or wallstand cover.
Start with field 2, it is the reference value of the center beam.
Measure the dose at the four side fields. Enter the values in the following table and calculate the heel factor value of the side fields (division of the center field value by the side field value):

Side field 1		Side field 3
	Center field 2	
Side field 5		Side field 4

Field 2 value		Values of			Heel factor value
	÷	Field 1		=	
		Field 3		=	
		Field 4		=	
		Field 5		=	

Measuring of the field sensitivities:

Set 70kV small focus and use the same 21 / 25mm Al filter. Remove the grid.

Switch at least 2 exposures per field and enter the mAs post indication values in the table.
mAs post indication values of two consecutive exposures should not deviate more than 5%, otherwise check the chamber signal if there is noise or any kind of modulation on it.

	Exp 1 mAs	Exp 2 mAs	Exp 3 mAs	Average mAs	Deviation see formula [%]
side field 1					
center field 2					
side field 3					
side field 4					
side field 5					

$$\frac{S - (C \times H)}{(C \times H)} \times 100\% = \%\ \text{deviation}$$

C = center field mAs = reference mAs
S = side field n mAs
H = side field n heel factor value

Page 27 provides tables for acceptance notes.

7.3. AEC RESPONSE TIME

Purpose

Verify that AEC meets the minimum response time that guarantees reproducible exposures especially in ranges with low dose requirements. Factors like cable length/capacity, kW from selected focal spot, control circuits, system absorption and the density reference = receptor speed must be taken into account.

Procedure

- Set 60 kV to start with.
- Set falling load technique > 30kW, large focal spot preferred to get max. load.
- Open collimator to max. size (some systems need a big cassette to get it opened).
- Select side fields only.
- No absorption in beam.
- Time measurement: non-invasive method in the beam.
- Switch two or more exposures in a row with the same kV value and calculate the mean value.
- Increase the high tension in 10kV steps up to 100kV or more until the min. exposure time is achieved (within a deviation of < 20%).

kV	60	70	80	90	100	110	120
tR stable < 20% deviation [ms]							

Limits:

tR = < 1.2 * tRS [ms]

tRS Optimus = 1ms (post indication ± 3% ± 0.5ms)

tR = max response time

tRS = specified response time from supplier

Remark:

Exposure times that have been monitored with an oscilloscope at the kV waveforms (high tension actual value, non-invasive) should be measured between 75% ± 7.5% of kVp at the high voltage rising edge and 75% ± 7.5% of kVp at the high voltage falling edge.

7.4. COMPLIANCE TEST

IEC 60601-2-7 chapter 50.102.2 b for AEC exposures

7.4.1. Prerequisites and exposure test series

- Use a 18x24cm / 7x9.5 inch cassette.
- Use only this cassette for the entire test procedure.
- Select only the center measuring field (2).
- Use only water as phantom (heights of 10/15/20cm or 4/6/8 inches required), the water must cover the entire cassette area to achieve a homogeneous density,
  the water phantom should be positioned as close as possible to the cassette.
- Set the generator / system controller to single step kV values to be able to set the kV values given in the table.
- Set an SID of 100cm / 40 inches with an appropriate grid mounted.
-
- Test series 1)

	water phantom height					
	10cm / 4 inch		15cm / 6 inch		20cm / 8 inch	
U[kV]	O.D.	t[ms]	O.D.	t[ms]	O.D.	t[ms]
60						
80						
100						
120						

Test series 2)

80kV		
15cm / 6 inch water phantom		
exp.	O.D.	t[ms]
1		
2		
3		
4		
5		

same exposure

7.5. EVALUATION OF MEASURING DATA:

7.5.1. kV compensation (IEC 60601-2-7 chapter 50.102.2 b-1)

Purpose

Verify that AEC compensates changes of kV

Procedure

- Calculate the mean value of the O.D. values of the **column 15cm / 6 inches** water phantom of exposure **test series 1)**.
  O.D. mean value =
- Check O.D. deviations from the mean value.
- Check O.D. deviations of adjoining density values.

Limits

max. Δ = 0.15 O.D. of O.D. mean value

and

max. Δ = 0.15 O.D. of adjoining values

Result

	60kV	80kV	100kV	120kV	condition Δ ≤ 0.15 O.D. complies	
O.D. deviations					yes	no

	60 ↔ 80 kV	80 ↔ 100 kV	100 ↔ 120 kV	condition Δ ≤ 0.15 O.D. complies	
O.D. deviation of adjoining values				yes	no

7.5.2. Thickness compensation (IEC 60601-2-7 chapter 50.102.2 b-2)

Purpose

Verify that AEC compensates changes of the thickness of an irradiated object (phantom / patient).

Procedure

- Compare the four pairs of exposures of **test series 1)** made at the same kV value but with different water phantom heights.

Limit

max. Δ = 0.20 O.D. deviation of each pair of exposures

Result

	60kV	80kV	100kV	120kV	condition Δ ≤ 0.20 O.D. complies	
O.D. pair deviations					yes	no

7.5.3. kV and thickness compensation (IEC 60601-2-7 chapter 50.102.2 b-3)

Purpose

Verify that AEC compensates changes of kV and the thickness of an irradiated object (phantom / patient).

Procedure

- Calculate the mean value of all eight O.D. values of the exposures taken at **test series 1)**.
  O.D. mean value =
- The deviation of the individual O.D. values to the mean value must not exceed the limit value.

Limit:

max. Δ = 0.20 O.D. deviation of the individual from the O.D. mean value

Result:

	water phantom height		
	10cm	15cm	20cm
U[kV]	Δ O.D.	Δ O.D.	Δ O.D.
60			
80			
100			
120			

condition Δ ≤ 0.20 O.D. complies	
yes	no

7.5.4. AEC reproducibility (IEC 60601-2-7 chapter 50.102.2 b-4)

Purpose

Verify that AEC terminates reproducibly within the coefficient of variation to guarantee reproducible exposures.

Procedure

- Calculate the mean value of the O.D. values taken in the exposure **test series 2)**.
  O.D. mean value =
- The deviation of the individual O.D. values to the mean value must not exceed the limit value.

Limit

max. Δ = 0.10 O.D. deviation of the individual from the O.D. mean value

Result

	1	2	3	4	5
O.D. deviations					

condition Δ ≤ 0.10 O.D. complies	
yes	no

8. SAFETY FUNCTIONS AEC

Purpose

Verify the functionality of the backup timer and mAs limiter.

Test conditions

Remove the existing chamber signal lines

Optimus	EZX 21 / 22 / 31 / 32 / 41
Velara	EZX 11 / 12 / 13 / 14

to simulate a total malfunction.

Keep the collimator closed for all following exposures to avoid unnecessary radiation.

Procedure

Release exposures with the following conditions and record the results in the brackets [**x**]

8.1. BACKUP TIMER AND SAFETY CUT-OUT OPTIMUS

a) Backup timer

- Set 60-70kV, select any focal spot.
- Program an APR with kV-mA technique RAECF.
  Select “No AEC technique = RUIT” and enter data 1 mAs – 1000ms – 1mA.
- Select the less sensitive film-screen-combination.
- The APR label must display the overriding “*” at the end of the APR label (e.g. by pushing a focus key).

Limit 4000 msec. (Philips spec. limit)

Results

Backup time 4000 msec. reached	YES [ ]	NO [ ]
Underexposure indication blinking 'X'	YES [ ]	NO [ ]
Manual reset necessary	YES [ ]	NO [ ]

b) Safety cut-out

- Set 60-70kV, select **large** focal spot **only**
- Select kV falling load technique
- Select the less sensitive film-screen-combination
- Set the + dose correction value to its maximum step
- The APR label must display the overriding “*” at the end of the APR label (e.g. by pushing a focus key)

Limit
580 mAs (default setting of Optimus) +0/-20 mAs (max limit 600mAs IEC 60601-2-7 chapter 29.1.104 e)

Results

HHS limit of 600 mAs	YES [ ]	NO [ ]
underexposure indication blinking 'X'	YES [ ]	NO [ ]
manual reset necessary	YES [ ]	NO [ ]

Explanations for premature exposure terminations and “AEC fault exposure detection strategy” can be found in chapter FAULT FINDING of the generator binder.

8.2. BACKUP TIMER AND SAFETY CUT-OUT VELARA

a) Backup timer:

- Set 60-70kV, select any focal spot
- Select kV-mA technique with the lowest mA possible, Automatic = yes
- Select the less sensitive film-screen-combination
- The hand symbol indicating manual mode will be displayed

Limit: 4000 msec. (Philips spec. limit)

There must be an attenuating object in front of the chamber field(s) depending on the selected kV and the selected film-screen combination.
With nothing in the beam the termination might be normal and too early, too much attenuation might activate the incorrect exposure supervision and the exposure will be interrupted.

Results:

backup time 4000 msec. reached	YES [ ]	NO [ ]
'Underexposure' message ON	YES [ ]	NO [ ]
manual reset necessary (message)	YES [ ]	NO [ ]

b) Safety cut-out:

- Set 60-70kV, select **large** focal spot **only**
- Select kV falling load technique
- Select the less sensitive film-screen-combination
- Set the + dose correction value to its maximum step
- The hand symbol indicating manual mode will be displayed

Limit:
580 mAs (default setting of Velara) +0/-20 mAs (max limit 600mAs IEC 60601-2-7 chapter 29.1.104 e)

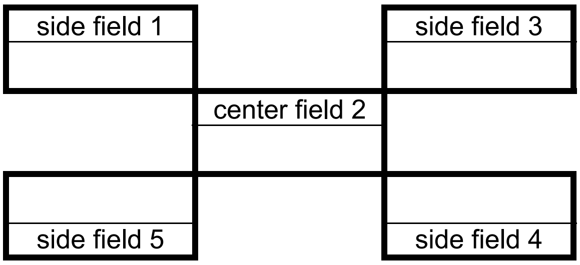
Results:

HHS limit of 600 mAs	YES [ ]	NO [ ]
'Underexposure' message ON	YES [ ]	NO [ ]
manual reset necessary (message)	YES [ ]	NO [ ]

Switch off and re-establish the Amplimat cable connections.

Acceptance notes

chamber serial number	
system type	
date	
system ID	



field 2 value		values of			heel factor value
	÷	field 1		=	
		field 3		=	
		field 4		=	
		field 5		=	

calculation details page 18

	exp 1 [mAs]	exp 2 [mAs]	exp 3 [mAs]	average mAs	deviation see formula [%]
side field 1					
center field 2					
side field 3					
side field 4					
side field 5					

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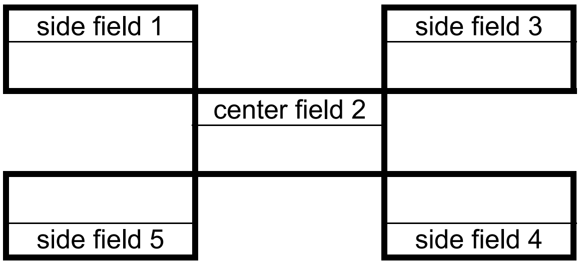
chamber serial number	
system type	
date	
system ID	

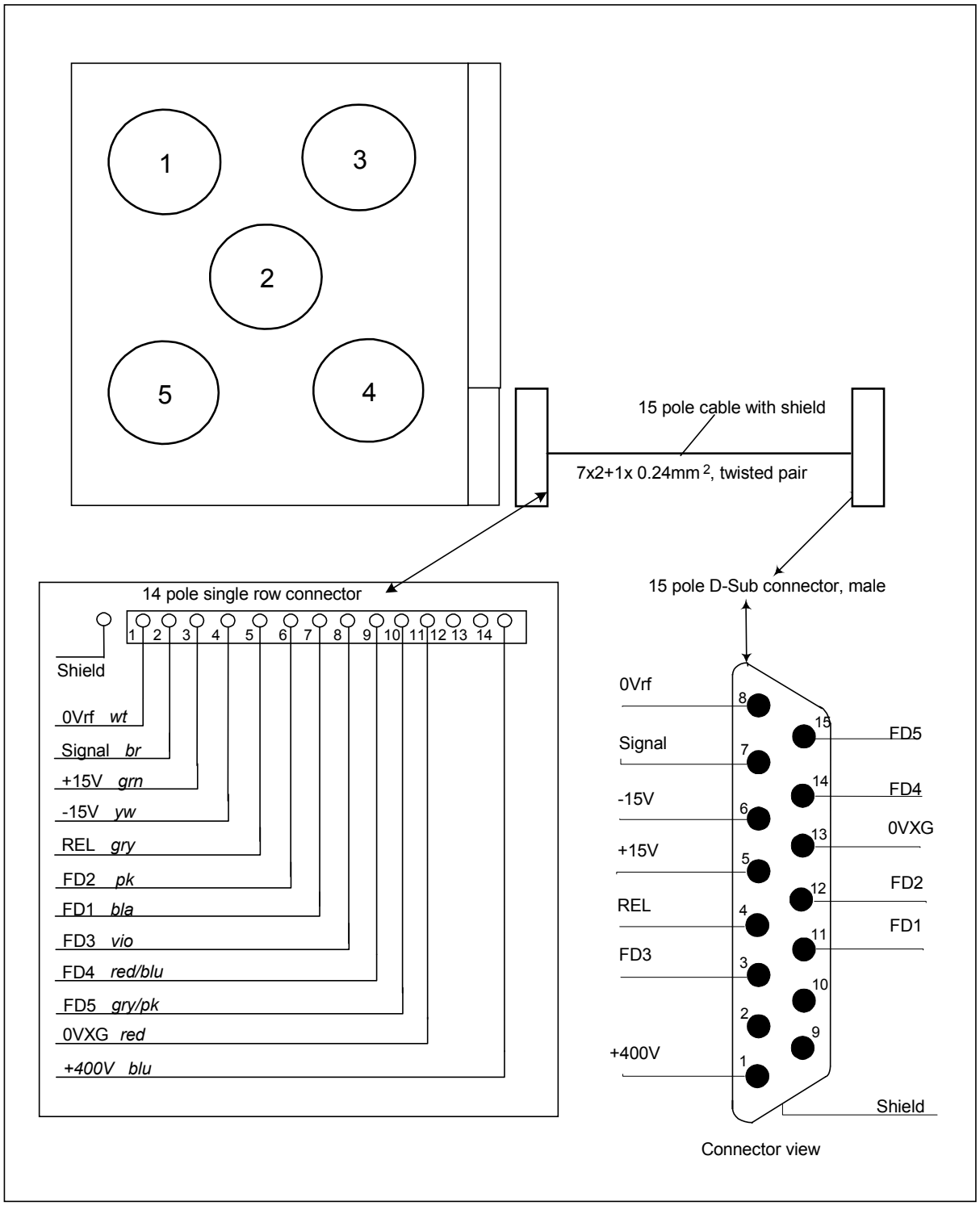


field 2 value		values of			heel factor value
	÷	field 1		=	
		field 3		=	
		field 4		=	
		field 5		=	

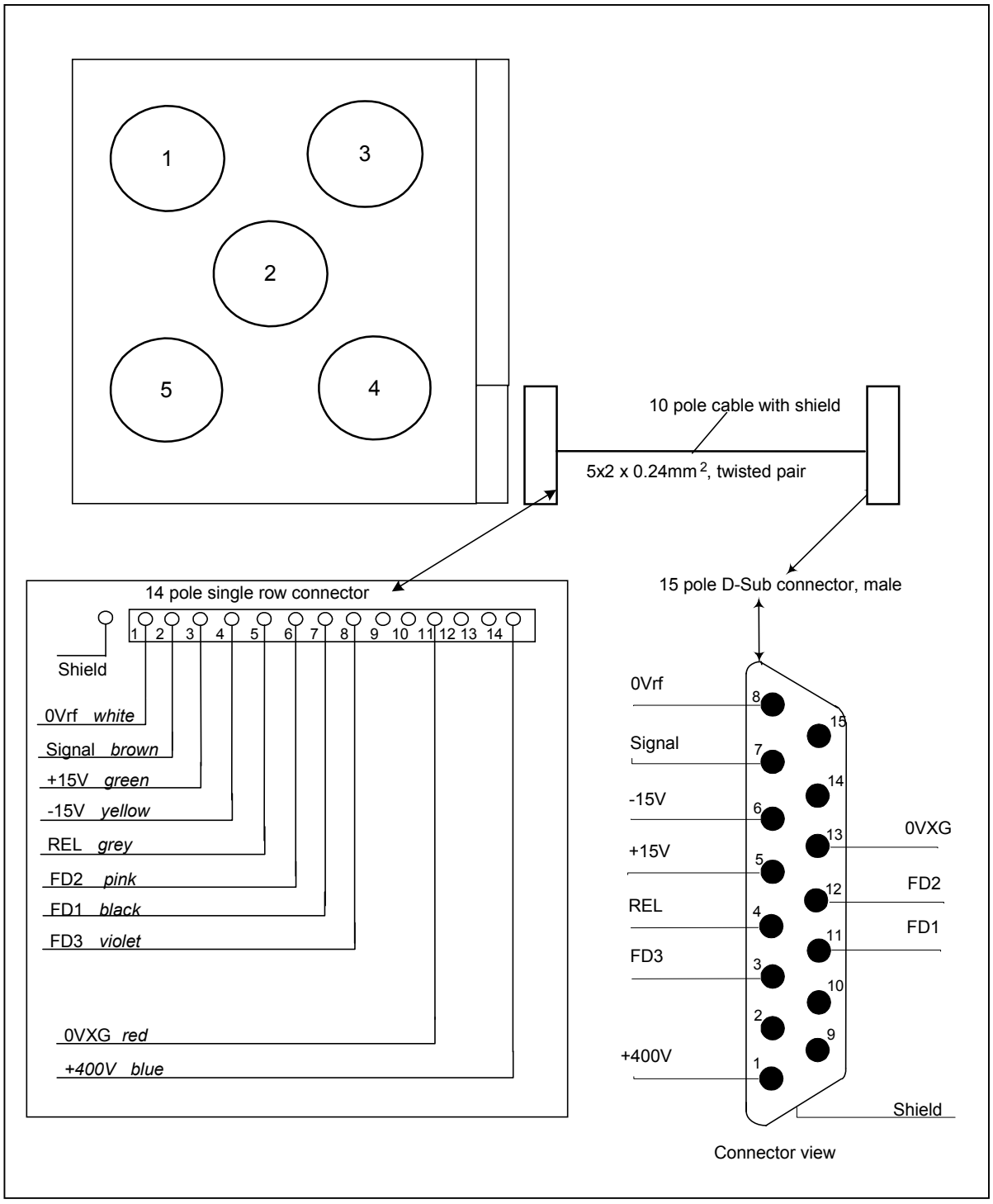
calculation details page 18

	exp 1 [mAs]	exp 2 [mAs]	exp 3 [mAs]	average mAs	deviation see formula [%]
side field 1					
center field 2					
side field 3					
side field 4					
side field 5					

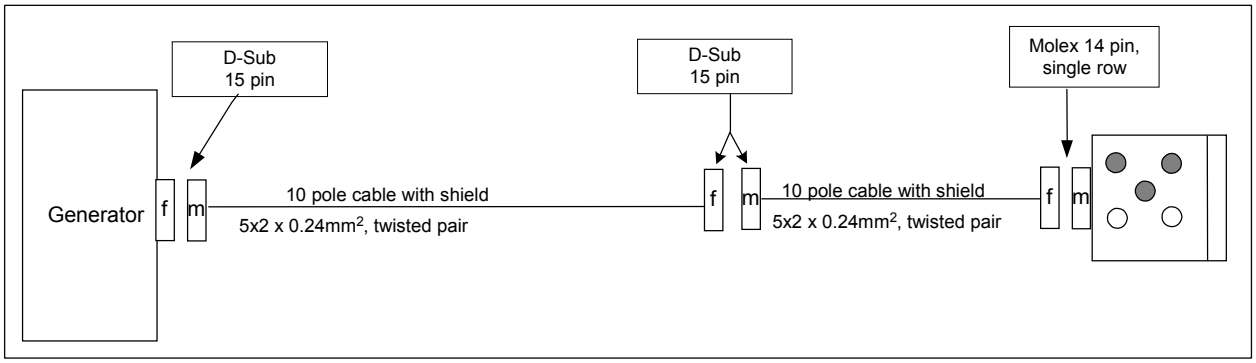
Z. DRAWINGS



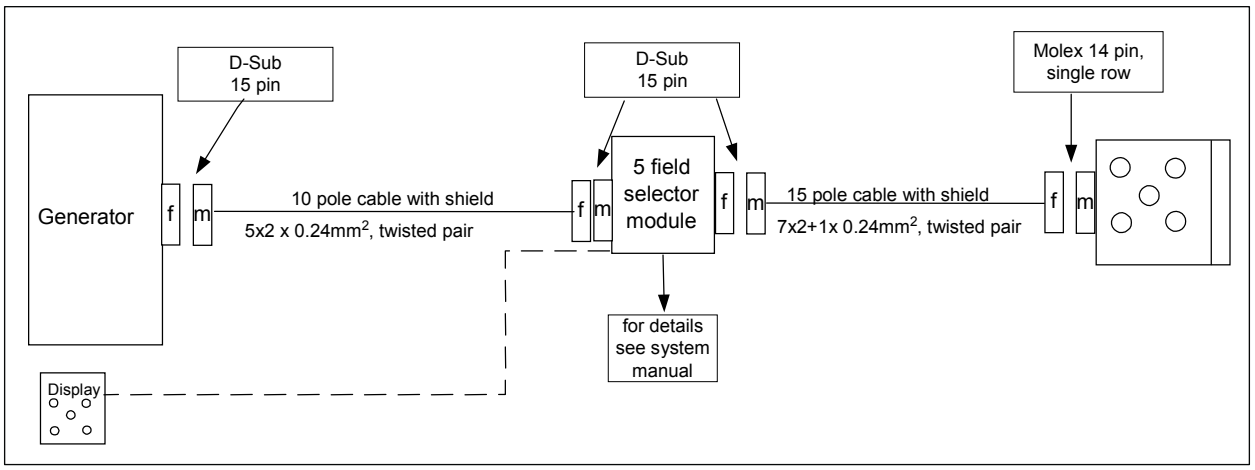
Cable and connectors, used as 5 field chamber



Cable and connectors, used as 3 field chamber



Cable and connectors, 3 field chamber
e.g. BuckyDiagnost TH



Cable and connectors, 5 field chamber
e.g. BuckyDiagnost VS